FIG. 1

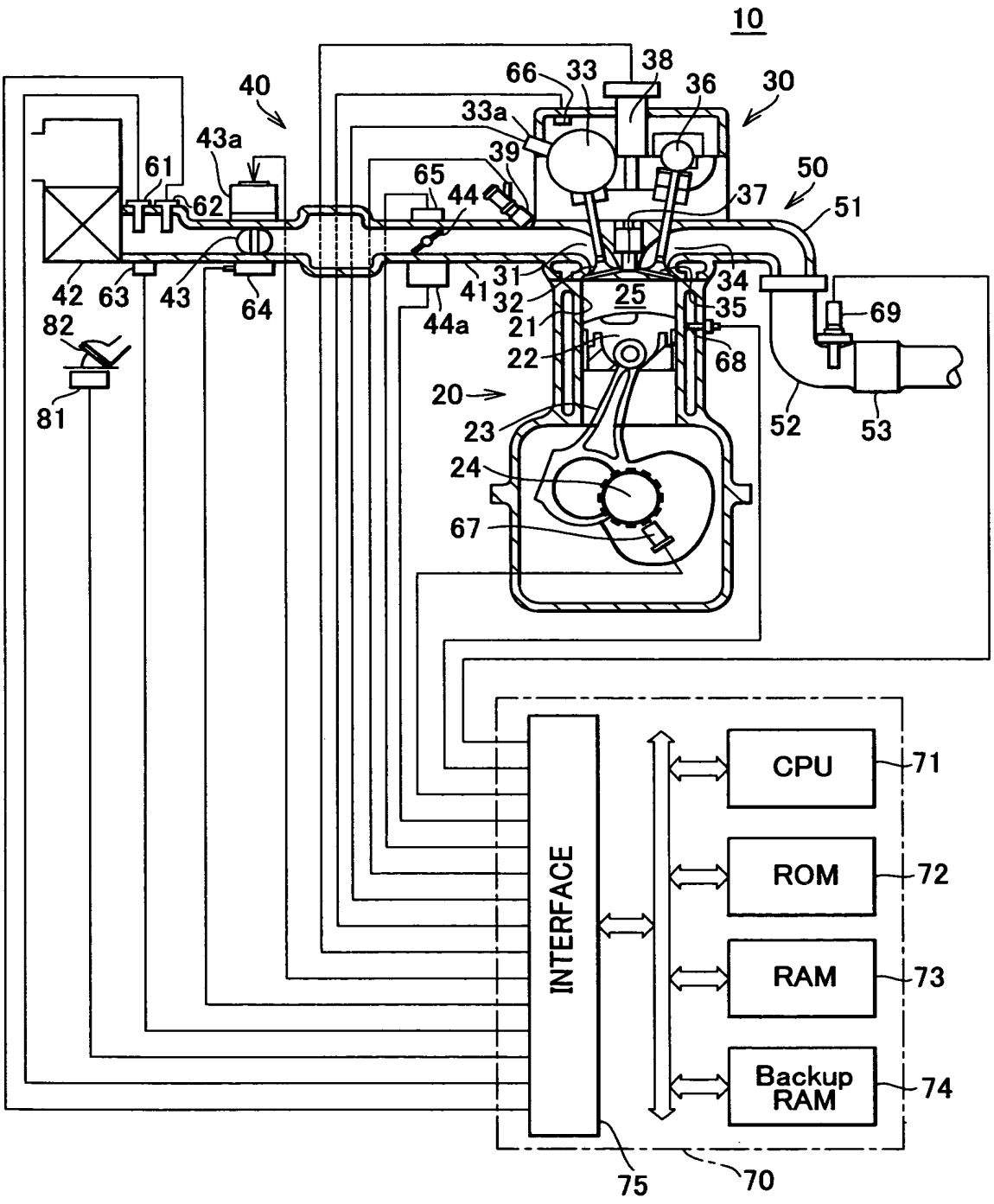

10
40
66
33
38
36
30
33a
43a
39
50
61
65
44
37
51
62
42
63
43
64
41
31
32
34
25
35
69
82
44a
21
22
68
20
81
52
53
23
24
67
CPU
71
INTERFACE
ROM
72
RAM
73
Backup RAM
74
75
70

FIG. 2

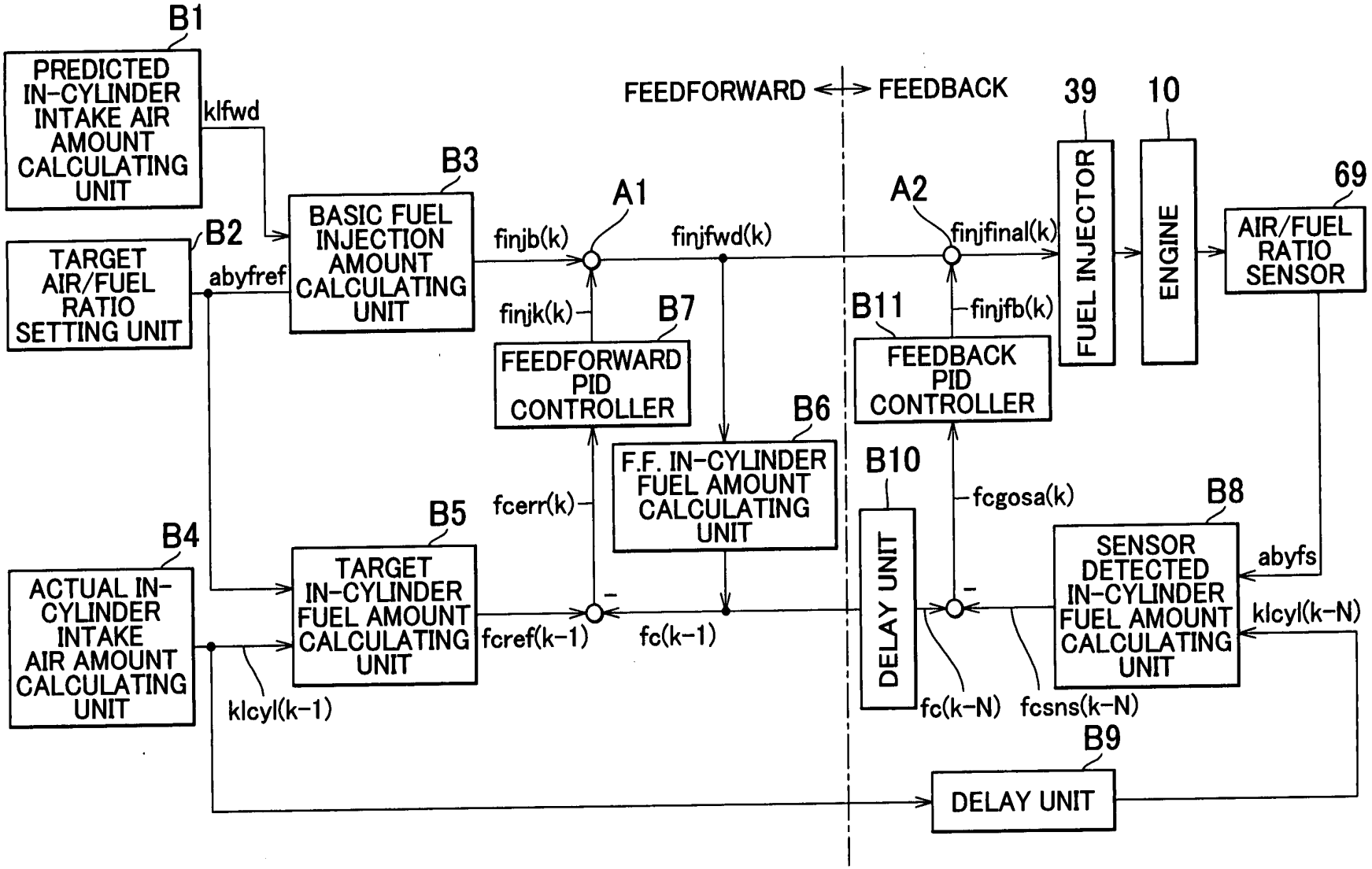

B1
PREDICTED IN-CYLINDER INTAKE AIR AMOUNT CALCULATING UNIT
klfwd
B2
TARGET AIR/FUEL RATIO SETTING UNIT
abyfref
B3
BASIC FUEL INJECTION AMOUNT CALCULATING UNIT
FEEDFORWARD
FEEDBACK
A1
finjb(k)
finjfwd(k)
A2
finjfinal(k)
39
FUEL INJECTOR
10
ENGINE
69
AIR/FUEL RATIO SENSOR
finjk(k)
B7
FEEDFORWARD PID CONTROLLER
B11
finjfb(k)
FEEDBACK PID CONTROLLER
B6
F.F. IN-CYLINDER FUEL AMOUNT CALCULATING UNIT
B10
fcgosa(k)
B8
abyfs
fcerr(k)
B5
B4
ACTUAL IN-CYLINDER INTAKE AIR AMOUNT CALCULATING UNIT
TARGET IN-CYLINDER FUEL AMOUNT CALCULATING UNIT
fcref(k-1)
fc(k-1)
DELAY UNIT
SENSOR DETECTED IN-CYLINDER FUEL AMOUNT CALCULATING UNIT
klcyl(k-N)
klcyl(k-1)
fc(k-N)
fcsns(k-N)
B9
DELAY UNIT

FIG. 3

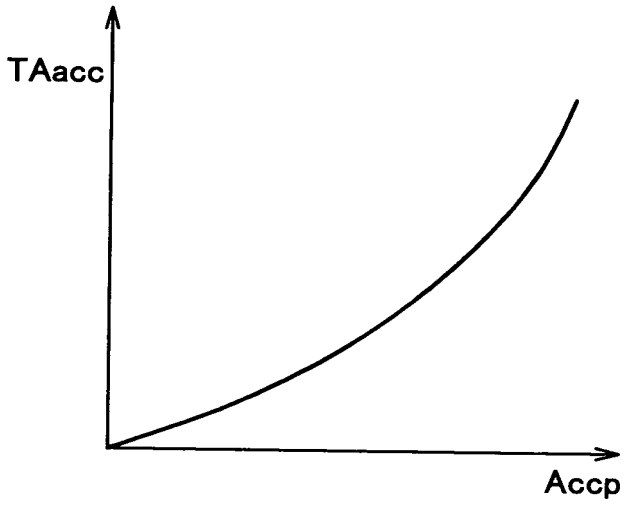


FIG. 4

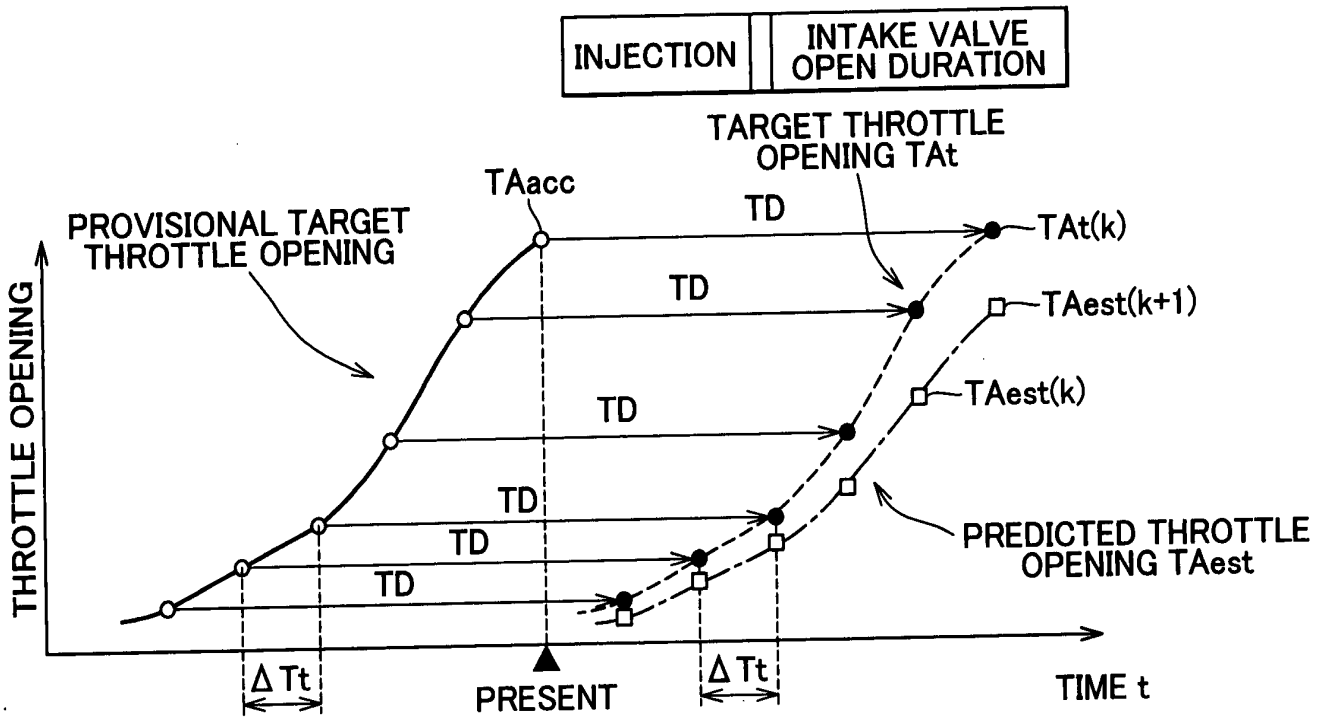

INJECTION
INTAKE VALVE OPEN DURATION
TARGET THROTTLE OPENING TAt
TAacc
PROVISIONAL TARGET THROTTLE OPENING
TD
TD
TD
TD
TD
TD
TAt(k)
TAest(k+1)
TAest(k)
PREDICTED THROTTLE OPENING TAest
THROTTLE OPENING
ΔTt
ΔTt
PRESENT
TIME t

FIG. 5

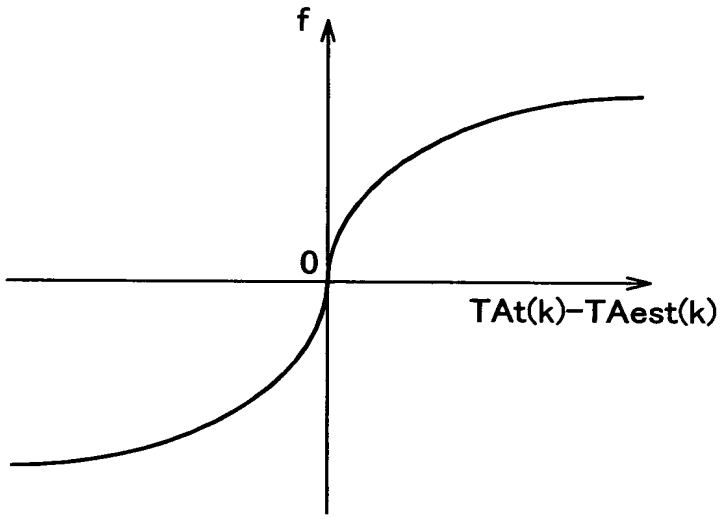


FIG. 6

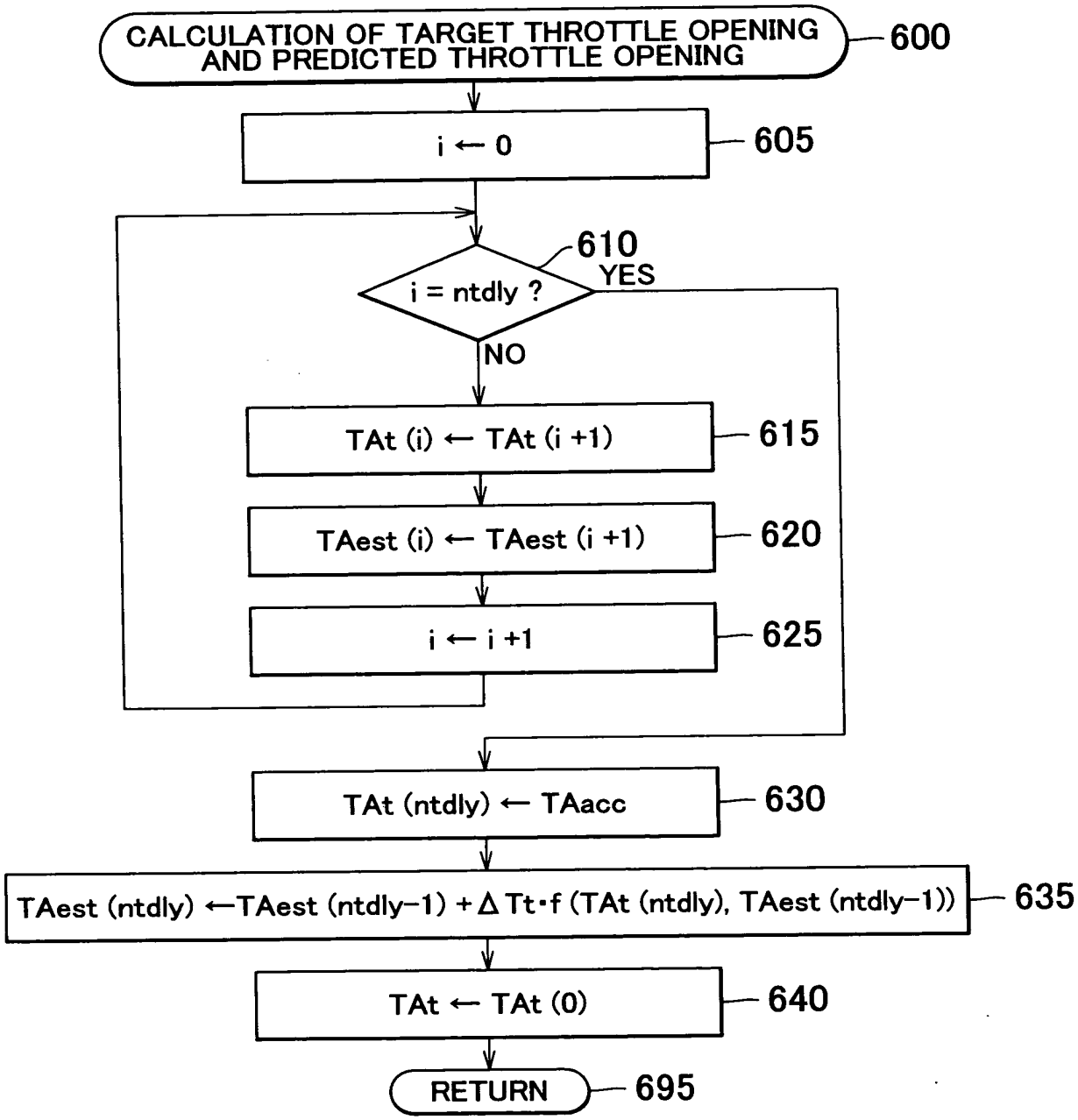

CALCULATION OF TARGET THROTTLE OPENING AND PREDICTED THROTTLE OPENING
600
i ← 0
605
610
i = ntdly ?
YES
NO
TAt (i) ← TAt (i +1)
615
TAest (i) ← TAest (i +1)
620
i ← i +1
625
TAt (ntdly) ← TAacc
630
TAest (ntdly) ←TAest (ntdly−1) + Δ Tt·f (TAt (ntdly), TAest (ntdly−1))
635
TAt ← TAt (0)
640
RETURN
695

FIG. 7

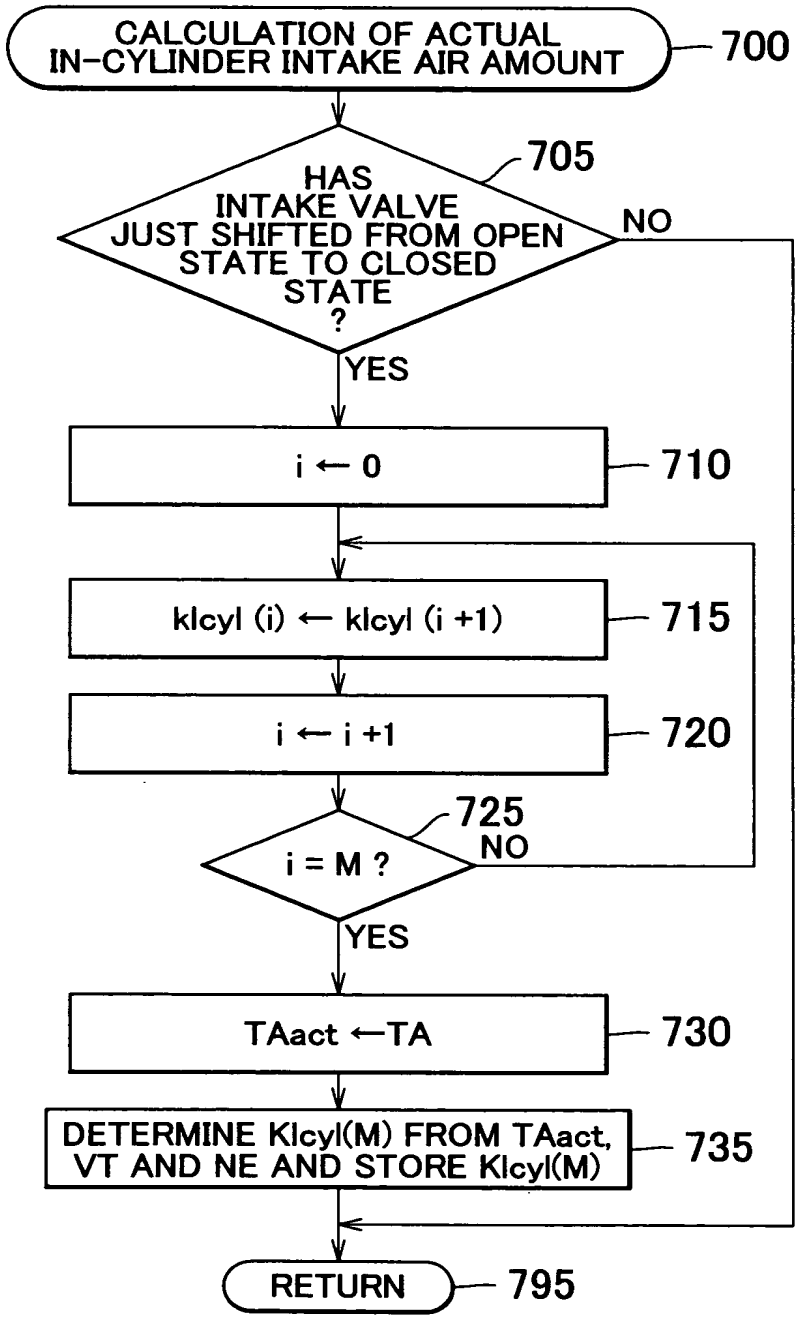
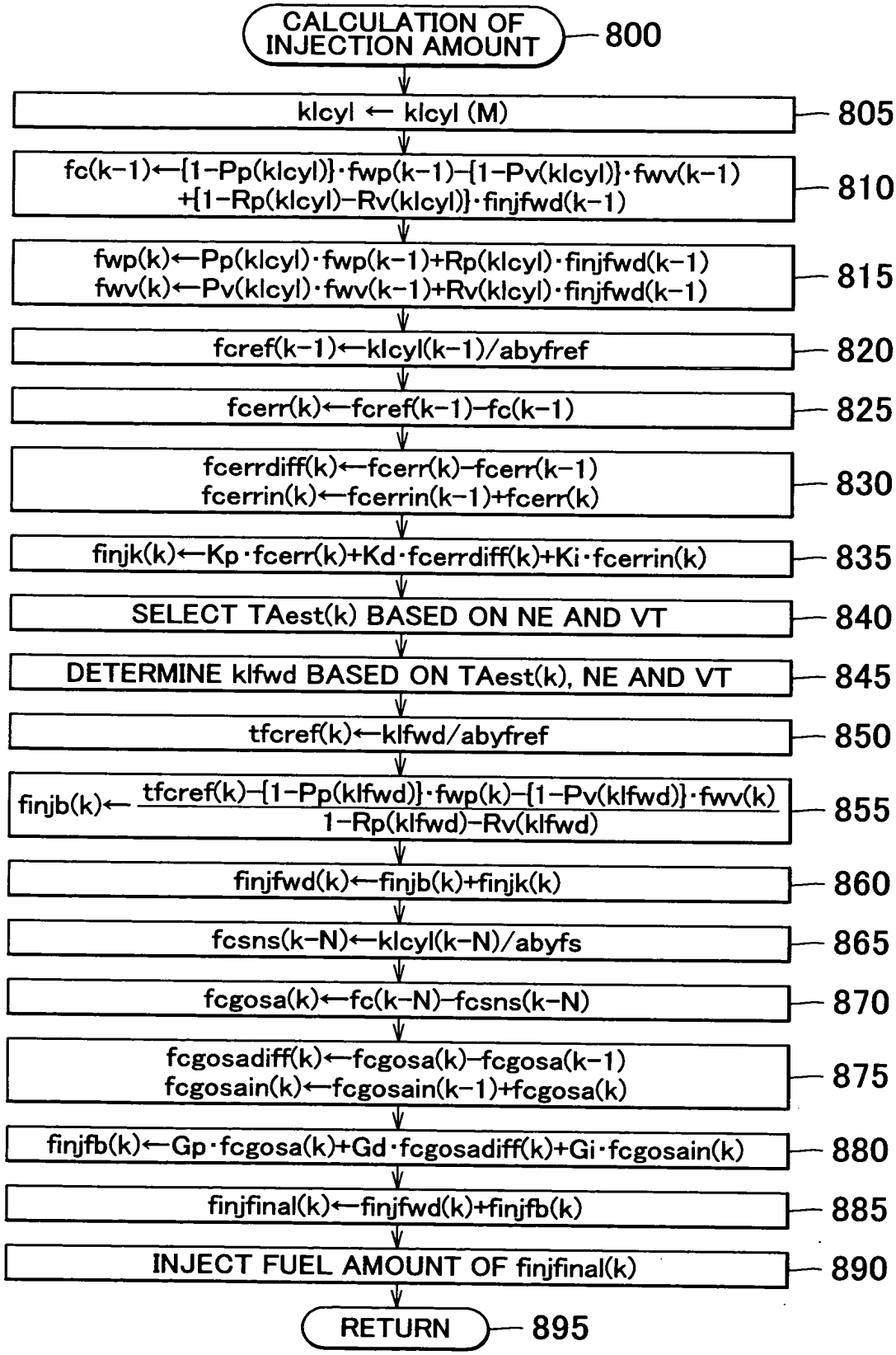

CALCULATION OF ACTUAL IN-CYLINDER INTAKE AIR AMOUNT
700
HAS INTAKE VALVE JUST SHIFTED FROM OPEN STATE TO CLOSED STATE ?
705
NO
YES
i ← 0
710
klcyl (i) ← klcyl (i +1)
715
i ← i +1
720
i = M ?
725
NO
YES
TAact ←TA
730
DETERMINE Klcyl(M) FROM TAact, VT AND NE AND STORE Klcyl(M)
735
RETURN
795

FIG. 8


CALCULATION OF INJECTION AMOUNT
800
klcyl ← klcyl (M)
805
fc(k-1)←{1-Pp(klcyl)}·fwp(k-1)-{1-Pv(klcyl)}·fwv(k-1)
+{1-Rp(klcyl)-Rv(klcyl)}·finjfwd(k-1)
810
fwp(k)←Pp(klcyl)·fwp(k-1)+Rp(klcyl)·finjfwd(k-1)
fwv(k)←Pv(klcyl)·fwv(k-1)+Rv(klcyl)·finjfwd(k-1)
815
fcref(k-1)←klcyl(k-1)/abyfref
820
fcerr(k)←fcref(k-1)-fc(k-1)
825
fcerrdiff(k)←fcerr(k)-fcerr(k-1)
fcerrin(k)←fcerrin(k-1)+fcerr(k)
830
finjk(k)←Kp·fcerr(k)+Kd·fcerrdiff(k)+Ki·fcerrin(k)
835
SELECT TAest(k) BASED ON NE AND VT
840
DETERMINE klfwd BASED ON TAest(k), NE AND VT
845
tfcref(k)←klfwd/abyfref
850
finjb(k)← tfcref(k)-{1-Pp(klfwd)}·fwp(k)-{1-Pv(klfwd)}·fwv(k) / 1-Rp(klfwd)-Rv(klfwd)
855
finjfwd(k)←finjb(k)+finjk(k)
860
fcsns(k-N)←klcyl(k-N)/abyfs
865
fcgosa(k)←fc(k-N)-fcsns(k-N)
870
fcgosadiff(k)←fcgosa(k)-fcgosa(k-1)
fcgosain(k)←fcgosain(k-1)+fcgosa(k)
875
finjfb(k)←Gp·fcgosa(k)+Gd·fcgosadiff(k)+Gi·fcgosain(k)
880
finjfinal(k)←finjfwd(k)+finjfb(k)
885
INJECT FUEL AMOUNT OF finjfinal(k)
890
RETURN
895